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PAPER I.

SIX LECTURES

DELIVERED AT THE

SENIOR OFFICERS' COURSE, 16-21 OCT. 1911,
SCHOOL OF MILITARY ENGINEERING,

BY

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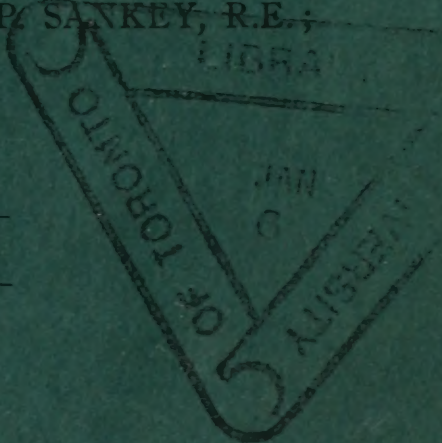
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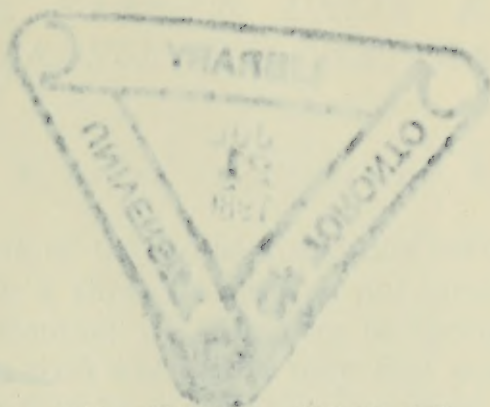
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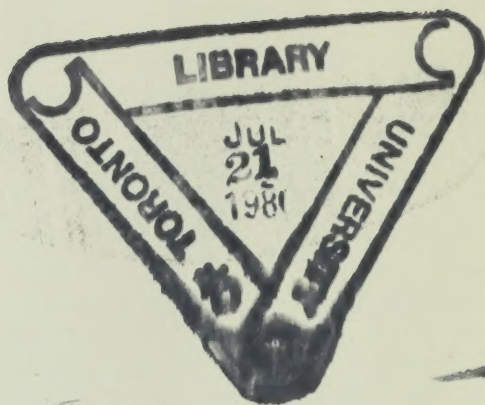
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SIX LECTURES AT THE SENIOR OFFICERS' COURSE, S.M.E., CHATHAM, 16-21 OCT. 1911.

THE following Lectures, which were delivered during the Senior Officers' Course at the S.M.E., Chatham, in October, 1911, have been published as a *Professional Paper*, as it has been thought they will prove of general interest.



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ORGANIZATION AND FUNCTIONS IN PEACE AND WAR OF THE VARIOUS UNITS R.E., WITH SPECIAL REFERENCE TO THE TRAINING AT CHATHAM.

By COLONEL J. E. CAPPER, C.B., COMMANDANT, S.M.E.

1. THE scope of the work of the Royal Engineers both in peace and in war is so large that in a short course it is not possible to deal in detail with all. Your attention will therefore be specially invited to the work of those units with which you may find yourselves more closely connected in the field in an ordinary campaign. It will only be possible to devote one lecture to the important subject of Fortress Warfare, and we can only touch in the lightest way on the work done at bases and on the Lines of Communication.

Owing to constant scientific progress the various units of R.E. are liable to frequent changes, and the next edition of official handbooks will probably show some units differently constituted and under different names.

2. "War Establishments, Expeditionary Force, 1910-11," lays down the Establishment of each R.E. unit forming part of the Expeditionary Force. These units are :—

A.—FIELD UNITS.

Length of Column on March.		Length of Column on March.	
*A Field Troop...	140 yards	*A Signal Company	
*A Field Company ...	300 „	(Cable)...	250 yards
*A Wireless Telegraph		*A Signal Company	
Company ...	140 „	(Air Line) ...	375 „
+Cyclists		A Balloon Company	160 „
A Divisional Tele-		*A Bridging Train ...	935 „
graph Company ...	80 yards		
+Cyclists			

B.—LINE OF COMMUNICATION UNITS.

*A Works Company.	*A Railway Company.
A Telegraph Company on the Lines of Communication.	A Central Railway Establish- ment.
A Railway Control Establishment.	A Railway District.

C.—UNITS NOT NORMALLY FORMING PART OF THE FORCE.

A Survey Company.

Note.—Where a unit is marked *, one or more similar units exist in peace either on a Peace Establishment or as a cadre. Other units do not exist under the same name in peace.

3. A definite number of certain Field Units is included in each Cavalry and Infantry Division, viz. :—

A Cavalry Division has R.E. Headquarters, 4 Field Troops, 1 Wireless Telegraph Company.

An Infantry Division has R.E. Headquarters, 2 Field Companies, 1 Divisional Telegraph Company.

Establishments only are laid down for other units, numbers of which can be formed as required for any particular campaign.

4. For the Field Army, in addition to existing authorized Field Units, a Printing Company will shortly be organized. A Search Light Company exists in peace and may be utilized in war. An Air Battalion also exists in peace from which it is proposed to form the Balloon Companies in war, and which will doubtless in the near future supply both Airship and Aeroplane Detachments.

5. There exist also in peace :—

Fortress Companies.—15 at home and 15 abroad.

Survey Companies.—3.

A large staff of officers, warrant officers and senior N.C.O.'s for Engineer Services.

Various Schools.

A large number of officers and a few N.C.O.'s for the Indian Establishment.

All these form a reserve which can be drawn on for war.

6. The work of Field Troops and Companies, Signal Companies and Fortress Units will be dealt with in special lectures. In this I will shortly summarize the work of other units.

7. The Balloon Company which may now be taken to include aeroplanes and airships will be employed for general strategical and tactical reconnaissance at all periods of a campaign and for observation of artillery fire. It will probably also be utilized for transport of maps and special reports, for transport of general and staff officers for special meetings and occasionally to give higher commanders a bird's-eye view of the battlefield. It is under the direct control of the Commander-in-Chief (F.S. Regs., I., 5-5). Each Balloon Company can put only one captive balloon or set of kites in the air at one time. The constitution as regards aeroplanes and airships is not yet laid down.

8. The Bridging Train is intended to supplement the small amount of rapid bridging equipment allotted to the Field Companies. It will

ordinarily march after the Supply and Transport Columns or even with the Parks (F.S. Regs., I., 27-2). It is under the direct control of the Commander-in-Chief and will be allotted by him as required (F.S. Regs., I., 5-5). It carries trestle and pontoon equipment for 400 yards of light bridge, for infantry in file; or 200 yards of medium bridge for field guns or horsed wagons; or 120 yards of special heavy bridge for 60-pr. gun. It does *not* include the *personnel* for making the bridges. In view of the necessity of providing for mechanical transport it is probable that the equipment of the Train will require reconsideration.

9. The main object of the Works Company is to provide a skeleton R.E. military organization for work on the Lines of Communication. Roadmaking, hutting, sanitary measures, water supply, buildings, etc., at the base and at the Lines of Communication come under its control. The works will as far as possible be carried out by civil labour and in civil shops, and will often be of a semi-permanent character. The collection and distribution of engineer stores is part of its duty, and it therefore includes a large storekeeping staff. It is capable of unlimited expansion if required. It in itself furnishes three small workshops. The headquarters will probably be at rail-head and there is a nucleus works staff for two advanced depôts and a storekeeping staff for the base. An important duty of the Works Company is to construct semi-permanent bridges in place of temporary ones constructed by the Field Companies—and generally to make good the temporary repairs carried out by more rapidly moving troops. The advent of mechanical transport will make great changes in the amount and nature of work to be carried out by the Works Company.

10. A TELEGRAPH COMPANY ON THE LINES OF COMMUNICATION.—This unit has no tools or stores for technical purposes in its equipment. It merely consists of officers and men fully equipped for war. Tools and stores are supplied by the D.A.T. It is divided into three sections and a Railway Section. Practically all rank and file are field, line or office telegraphists. It can erect and maintain 100 miles of air line with ten offices. The establishment is liable to variation according to circumstances, *e.g.* a Railway Section will be mobilized for each railway district.

11. THE RAILWAY UNITS.—The Railway Company's duty is to survey, construct, repair and demolish railways, and to work its construction trains and armoured trains. Its work includes water supply, erection of extra platforms, repairs to telegraph lines, and generally any "works" services in connection with the railway. It will ordinarily be employed on that section of a line nearest to the front. It has ordinarily nothing to do with traffic arrangements, but may be required to work a short section of line in close proximity to the enemy.

The Railway Control Establishment consists of a number of officers, clerks and checkers stationed at the entraining base, at rail-

head, or at any station used as an advanced base, and at large junctions or stations where troop trains usually halt for feeding, etc. It receives orders only through the Director of Railways, except when fighting is imminent, and its orders as regards railway matters are paramount. It acts as the Military Railway Staff and it, and not the Civilian Staff, will be referred to by troops on all railway matters. It arranges all details as regards entraining and detraining of troops, and is responsible that necessary rolling stock is provided and that troops and stores are detrained with the utmost despatch. It also arranges under orders of I.G.C. for meals for troops *en route*.

The duties of the Central Railway Establishment and the Railway District are not defined. One Central Railway Establishment and two Districts would furnish a corps about 900 strong for working a railway in a hostile country where the Civil Staff could not be utilized for working the railways.

12. A Survey Section consists of 2 officers, 7 surveyors and 3 lithographers and transport. It is required when accurate maps of the theatre of war are not available.

13. A Printing Company will consist of 1 officer, 14 lithographers, 9 printers and 8 photographers. Its chief duties are :—

- (i.). The rapid reproduction in the field of sketches and preparation of enlargements of small scale maps.
- (ii.). Rapid reproduction of circulars, orders, etc.
- (iii.). Photography to illustrate reconnaissances and reports.

It is divided into four sections :—

- 1 with general headquarters.
- 2 mobile sections.
- 1 lines of communication section.

Taking a sketch with ordinary detail $15'' \times 12''$ you can count on 250 copies (in one colour) in six hours. For smaller numbers 50 can be produced in from one to two hours.

14. Fortress Companies mobilize at peace strength. When not required for fortress warfare, they can be utilized as reserves for the Field Army, and for Railway or Works Companies. They can be equipped as required for any special service.

15. It will be seen that the units of R.E. with which you come in close contact in the field do not constitute the whole of the Corps, but there are and must always be, a large number of men and especially a large number of officers who are doing work of the utmost importance to the army, whose presence in the theatre of war is hardly realized by those whose duties keep them closer to the front—and that these officers and men are interchangeable with those employed in the purely Field Units.

16. The numbers employed in peace with what may be called

Field Units, in comparison with the total establishment of the Corps, is as follows :—

	With Field Units.		Total Establishment.		Per Cent
	British.	Indian.	British.	Indian.	
Officers under the Rank of Lieut.-Col.	124	66	608	370	19·5
Warrant Officers, N.C.O.'s and Men.....	4105		9111		45

The table very clearly shows that only one-fifth of the officers and less than one-half of the men are under direct training in peace for work with the Field Units of the army.

The majority of the Corps in peace is employed on various engineering duties which both render them remunerative and give them practical experience which is of the greatest utility as a preparation for many of their duties in war.

17. The instruction given to officers at the School of Military Engineering therefore includes grounding in many branches of engineering which would not at first sight appear necessary to military engineers.

That given to men, is, with the exception of special instruction to men undertaking special duties in peace, purely elementary training to enable a man to take his place in the ranks of a unit as a fairly trained sapper.

18. The Schools at the S.M.E. are divided into :—

(i.). MILITARY DUTIES.—Discipline, Drills, Musketry, Interior Economy, Tactics.

(ii.). SURVEY.—Topographical Engineering and Field Sketching.

(iii.). FORTIFICATION.—Fieldworks, Temporary Bridges, Fortress and Siege Works.

(iv.). WORKSHOPS.—Organization, Use of Tools and Machines, Steam and Internal Combustion Engines.

(v.). CONSTRUCTION.—Civil Engineering of all sorts, Water Supply, Sanitation.

(vi.). ELECTRICITY.—Telegraphs, Telephones, Search Lights, Power and Lighting Plants.

(vii.). ENGINEER RECONNAISSANCE IN WAR.

The course for young officers lasts for 21 months only, and entails incessant work on the part of both instructors and students.

19. Special courses are given to senior R.E. officers and to N.C.O.'s and men to fit them for various duties, and a number of classes of Special Reserve and Territorial officers are also held during the year.

CO-OPERATION OF R.E. WITH OTHER ARMS IN WAR AND PEACE.

By LIEUT.-COLONEL J. A. GIBBON, R.E.

I.—I. Necessity for Co-operation both on and off the Battlefield.

OUR subject to-day is Tactical Co-operation in the Field, but the duties of the R.E. in war are at least as important and generally much more extensive off the battlefield than on it.

Modern warfare demands an enormous amount of labour both on and off the battlefield, and although some of this may be done by R.E. and other special corps, and some by civil labour, yet a great part of it must inevitably be done by the infantry, if it is to be done at all; and the need for willing and ready co-operation in all work which concerns the efficiency of the Army is imperative.

It is certain that the introduction of mechanical transport means a great increase of work to the engineers in the upkeep of roads, and sometimes in their construction. The mass of mechanical vehicles will quickly destroy, in bad weather, anything but the best roads. It will be impossible for the R.E. to carry out this work without the assistance of other arms, especially of the R.A. for transport of road materials.

In these days, as we have been painfully reminded by the railway strike, we are all dependent for our existence on the work of the engineer and mechanist, and a field army is no exception to this rule.

At Bloemfontein in 1900 we lost over 4,500 men by death and invaliding in a few weeks, largely owing to bad water, caused by the destruction of the machinery of the waterworks.

If any C.R.E. had proposed, when the town was first occupied, that the troops should go on half rations for a day or two in order that the necessary materials for repairs of the waterworks might be brought by road from Kimberley, he might likely have been sent down to the base without even waiting for a medical board! But had the army realized what the loss of good drinking water would mean to them, they would gladly have done without a day's food if necessary, so that good water might be forthcoming, and such co-operation with the engineers might have saved more lives than were lost at Magersfontein or Spion Kop.

General Sir Charles Douglas in his report on the training in the Southern Command for 1911, says:—

“There appears to be an inherent dislike, on the part of infantry commanders, to co-operate with the engineers, due to lack of close

association with, and knowledge of, the functions of the sappers on the battlefield."

Whatever difficulties there may be, I am sure that the fault lies at least as much with the engineers as with the infantry. We have done so long without one another, at any rate in peace training, that we have come to think that the engineers should always work on their own, and when we engineers need the assistance of infantry, or the infantry need ours, we do not know how to set about it.

We want this afternoon to discuss not so much the theory of co-operation, which is laid down quite clearly in the textbooks, as the practice of it, and what are the practical difficulties in the way and how they can best be overcome.

In some respects these difficulties are much greater in peace than in war, because most of the R.E. work, such as demolitions, hasty conversions of houses, cutting materials for head cover, etc., can rarely be done in peace. If however we do not work together in peace there is a great danger that we shall fail to do so in war.

First then let us note that the sappers are artizans, trained as infantry, who are nothing if they are not fighting soldiers, and who many times in the past have helped to "turn the battle at the gate." If this was better realized we should not hear any complaints of the field companies, R.E., "not being wanted," except for special purposes.

Tactical co-operation must begin between the C.R.E. and the General Staff. The C.R.E. is the technical adviser of the G.O.C. in all R.E. questions. So also should be the senior officer, R.E., with each brigade or detachment. It is essential, if the R.E. are to render the assistance to the other arms which is necessary, that they should have the very latest available information as to their dispositions, movements and objectives. This information can only be obtained from the G.O.C. himself, or the General Staff; it is therefore essential that the senior R.E. officer with any force should be constantly in touch with the Staff, and fully acquainted with the G.O.C.'s wishes and intentions. It is most desirable before actual orders are issued by the Staff that the senior R.E. officer should be able to suggest the best methods of utilizing the R.E.

II.—Co-operation with the Staff.

It is essential alike for the Royal Artillery and Royal Engineers to have full knowledge of the G.O.C.'s plans and dispositions, as well as all available information of what is happening in front; in other respects however there is a great difference between the assistance which can be rendered by the R.A. and that of the R.E.

III.—Co-operation of the R.A. with Infantry compared with that of the R.E. with Infantry.

Royal Artillery co-operation with infantry can often be made effective immediately the need of it is realized at distances up to 4 miles.

Infantry co-operation with infantry becomes effective the moment the supporting troops come up, but engineer co-operation with

infantry does not become effective until at the very least half an hour after their arrival on the spot, and generally much longer still. Moreover R.E. co-operation involves more often than not the assistance of other infantry, who must usually be supplied from the local or other reserves.

IV.—Detail
of Ways of
Co-operation
of R.E. with
other Arms.

Royal Artillery co-operate with infantry in one way only, that is by shrapnel fire.

Royal Engineer co-operation may be by demolitions, mines, blocking of roads, bridging, making roads and communications, construction of obstacles or inundations, flare lights, loopholes, fortifying buildings, entrenchments, destruction of obstacles, throwing hand-grenades, water supply, reconnaissance, siting and laying out of defensive works, collection of local materials and collection and supervision of civil labour. These are the seventeen ordinary ways, but there are many other special ones.

With such a variety of methods of assisting other troops it is most desirable that there should be a R.E. officer on the spot who can suggest to the staff or local commander how the R.E. can best assist the other arms.

V.—Informa-
tion and
Assistance
necessary
for R.E.

The responsible R.E. officer must have :—

(1). All available information as to the movements, and dispositions of other troops and of the enemy, as well as the intentions of the G.O.C.

(2). He must have all the special information that an effective engineer reconnaissance can discover.

(3). He must have the engineer companies close to the spot where the work is required ; if not the assistance will probably come too late.

(4). He must have every possible assistance from the infantry, not only in covering parties and working parties when necessary, but also by their sending back information of captured points which require entrenching, or other work for engineers.

VI.—Lack
of Co-
operation on
Manœuvres.

It has been a frequent experience at our manœuvres that the R.E. have put some place in a state of defence, which the officer commanding the infantry, on arrival on the spot, has refused to occupy, as he has preferred some other disposition of the men under his command. The R.E. duty on these occasions is primarily to prepare a skeleton or framework for the defence, to be filled up by the infantry. If the infantry do not co-operate there may, and often does, result a complete lack of co-ordination in the lines of defence, the trenches of adjoining units overlapping if not actually firing into each other. The remedy for this appears to lie in a closer touch between the senior R.E. officer and the infantry brigadier and his staff, as well as a better mutual understanding between the commanding officers of infantry and engineers.

Until such co-operation has become a definite custom of the Service the only way it can be brought about during our peace training, is by

mutual knowledge and intercourse between R.E. company commanders and the brigadier-generals and their staff, to whom they are attached during manœuvres; the practical difficulty of this is that there are only two field companies to three brigades, but it is hoped that this difficulty will shortly be removed.

Engineer officers are apt perhaps to complain that the infantry officers do not well understand what services they are capable of rendering to them, but, on the other hand, it is equally true that R.E. officers are not fully in touch with the infantry ideas and system, and we do not know the best way to set about getting the assistance from them which we require. These difficulties are quickly overcome by mutual intercourse and personal knowledge; but if the R.E. companies are only occasionally attached to brigades, and are frequently away from them, when perhaps they would be most useful, the brigadier-general and his staff get into the habit of doing without them, and so do not know what to do with them when they are available.

Let us now consider the co-operation of engineers with other arms in the occupation of a defensive position.

VII.—Co-operation in a Defensive Position.

Infantry Training, 1911, just published, lays down that every position should be taken up, in the first instance at any rate, by occupying only the principal tactical points in the line chosen. In the French Army it is the duty of the C.R.E., accompanied by a General Staff Officer and an officer of artillery, to select these points as soon as the general line has been decided on by the G.O.C. It is impossible for the section commanders to satisfactorily select these points for themselves, since so much depends on the exact position of the points in the adjoining sections.

It is certain that the best co-operation of the R.E. in this most important of their duties cannot be secured unless the G.O.C. takes the C.R.E. very fully into his confidence.

2. Duties of C.R.E.

When the G.O.C. has decided on the arrangements for defence, it is important that, in addition to written orders, verbal instructions should be given on the spot to the section commanders, so as to ensure full co-operation of the defence. The C.R.E. should always be present when this is done. Similarly when the section commander issues his instructions the senior officer, R.E., should be present.

Finally in the case of the entrenchment of a defensive post, to which perhaps half a battalion and one section R.E. may be allotted. The senior officer present would probably be an infantry officer, and he must therefore be responsible for the entrenchment of the post, subject of course to any instructions which have been received from the G.O.C. through the Staff.

3. Entrenching a Defensive Post.

It is a very important and practical question how a section of Royal Engineers, which consists of most of some 37 sappers, can best assist the infantry in the work of fortifying the post. The old method

laid down in the textbooks was to distribute a certain number of sappers to each infantry working party, these parties being made up of any number of men, as appeared most convenient for the work, quite irrespective of the company organization. This was of course entirely wrong. The work must be arranged to suit the company organization of sections and squads. Similarly the R.E. sections are organized into two squads, each commanded by a sergeant or corporal, and these squads are further divided into groups, and the work should be arranged accordingly.

To begin with the commander of the post would decide, in consultation with the R.E. officer, what work can be carried out by the infantry alone, and allot this work to the different companies, and the company commanders to their sections. The work to be done by the R.E. should be allotted by the R.E. section commander, and he should be left to carry it out in his own way. In addition it would be generally desirable that say, half a company of infantry should be placed at his disposal to work as labourers with the sappers, but even so the control of these men should remain entirely with their own N.C.O.'s.

It is laid down in the Regulations (M.F.E., 18-1) that the infantry should, as far as possible, themselves construct the trenches which they intend to occupy. If overhead cover is required, it would best be constructed by the R.E., with the assistance of the infantry detailed to work with them. While the trenches were being dug the R.E. would collect the necessary materials. As soon as the trenches had been completed the R.E. would proceed to construct the loopholes and overhead cover. If more overhead cover was required than the very limited number of Royal Engineers could construct, they should make specimen lengths of it in each trench. It has been found that the infantry readily copy actual examples of work, where verbal instructions as to how to do the work had proved quite ineffective.

In the same way with wire entanglements, the infantry might collect the materials, the R.E. put up some short lengths as specimens, and the infantry can then without difficulty complete the rest. It will be seen that under this system there is no difficulty for the R.E. officer in command to allot the separate tasks to his sub-sections and groups, assisted where necessary by the infantry allotted to him, without breaking up the section organization, or taking the men away from their proper N.C.O.'s.

The R.E. can further assist by flares, mines, traverses, magazines, putting houses in a state of defence, as well as helping to clear the foreground.

The principal duties of R.E. in attack are to clear away or destroy obstacles, cut wires of land mines, and above all to arrange for the entrenchment of captured positions. In the Russo-Japanese War on many occasions the Japanese lost positions, which they had only

captured after desperate fighting. It is at least as important that the entrenchments of captured positions should be properly organized on a sound system as in the case of an ordinary defensive position, but the difficulties of working on a system owing to the confusion of units, exhaustion of the troops, are very much greater. These difficulties however only serve to accentuate the necessity of a proper system of defence so as to minimize the time and labour required.

The system which has been proposed for the occupation of a defensive position can be applied; work being concentrated on the important tactical points. It is the duty of the C.R.E. or senior R.E. officer on the spot under orders of the G.O.C. or of the local commander to have his due share in arranging the defences, with of course the guidance of the General Staff, because the C.R.E., not being a staff officer, can issue no orders as such.

The duties of the R.E. with a rear guard are to block the roads at suitable places by felling trees, etc., at points where it is difficult for vehicles to make a detour, destroy bridges and culverts. Where the road runs through boggy ground the road metal may be removed for a short distance, and the road flooded, and signposts on roads may be turned round. All obstructions have to be completed after the last vehicles of the rear guard have passed, so that complete preparation must be made beforehand to enable them to be finished in the shortest possible time.

5. Co-operation of the Royal Engineers with a Rear Guard.

There are eight cyclists in each section of a Field Company, and at a pinch eight sappers as well can be moved at a trot on the section tool cart for a short distance. A Field Company has therefore a considerable mobility, which is invaluable for such work. The officers and men not required for the above purposes should go on ahead to arrange rear-guard positions, with the assistance of any infantry kept in reserve.

Probably little or no time would be available for actual entrenching, but it will be of the greatest assistance to the other arms if they know exactly what points to retire on to, and have a clear road made straight into these positions, concealed wherever possible from the advancing enemy; this done the sappers may cover the retirement of the infantry into their positions by their fire, and then proceed to make good lines of retirement out of the positions; and subsequently to repeat the process again in the next position if necessary.

The Field Company of the advanced guard usually marches with the main guard. The first duty of the Officer Commanding Royal Engineers is to arrange for an engineer reconnaissance, for this purpose an officer and say eight or more cyclists should march with the vanguard, carrying tools and some explosives on their bicycles for the removal of obstacles on the road. Their special duty is to examine all bridges and culverts and to report immediately to the O.C. Royal Engineers on any obstacle which they themselves cannot remove.

6. Co-operation with the Advanced Guard.

This reconnaissance should include all parallel roads likely to be traversed by the troops.

If the vanguard is attacked by a superior force of the enemy the Field Company, R.E., would usually best be employed in taking up a covering position in rear.

7. Co-operation in forcing the Passage of a River.

Even in peace training where the schemes for crossing a river are usually more or less cut and dried, there is sometimes a conspicuous lack of co-operation between the R.E. and other arms. It is most essential that the R.E. should select the sites for the crossing, especially where guns have to be got over, not only on account of the difficulties of the actual bridging, but of getting suitable approaches where the banks are steep or the ground marshy; moreover, it is generally necessary to bring up the pontoon wagons very early, and this can only be done where a more or less covered line of approach can be obtained.

It is often found that the infantry dispositions have been made with a view to facilitate their fire fight, rather than the construction of the necessary bridges.

When the bridges have been completed a further difficulty arises as to whether the nearest troops should cross at once or not, the R.E. officer in charge is often appealed to on this point; which of course he cannot decide.

These difficulties emphasize the necessity for the closest co-operation between the senior R.E. officer and the staff of a force with which he is working.

It is not necessary to point out that this co-operation is made very much easier if the field company is attached to a brigade with which it has been accustomed to work. The difficulties also show the necessity for some more definite recognition, if not in the Regulations, at any rate in the customs of the Service, of the responsibility and authority of the senior R.E. officer even if he is only a subaltern, in all operations for which the R.E. are primarily responsible.

In a recent case on manœuvres the officer commanding a Field Company, R.E., having been ordered to construct a bridge found that the site of the bridge was in an exposed position, and that there was no covering party near; nor could he obtain one until after some search he fortunately found a brigade major who immediately detailed the necessary troops. In consequence of this difficulty considerable delay eventually ensued in the crossing of the river and the attack.

VIII.—Assistance to R.E. not to be "Unreasonably Refused."

It is laid down in Field Service Regulations that the senior officer, R.A., is entitled to demand an escort on his own authority from any neighbouring troops and that the escort then works under his orders.

It would immensely facilitate the co-operation of the engineers with other arms if it was a recognized custom that the senior officer, R.E., should demand assistance in the same way from other arms, and

that this assistance was not to be "unreasonably refused." At present the R.E. officer is not entitled to ask, nor is the infantry officer entitled to supply such assistance.

It is important however to note that the R.E. only require assistance or covering parties when at work. They can protect themselves and their 1st Line Transport fully on the line of march.

It remains now to consider the question of how the sappers of Field IX. — 1. R.E. Companies can actually be employed on manœuvres. Field Companies on Manœuvres.

Of all the 17 ordinary ways in which R.E. can assist other arms, which have been previously enumerated, if we except water supply, bridging is the only one which can normally be done in practice, and that, moreover, is limited to the use of the service equipment.

It is true that fairly often trenches can be dug, and in special cases 2. In Defence. R.E. may have to do this ; but when troops are available for digging their own trenches, it is wrong, and gives a really misleading idea of R.E. co-operation, to make the engineers do the same ; because if they are employed in this way they must neglect other, and much more valuable, ways of assisting the other arms.

If digging is the only possible work, the R.E. can be employed in building good traverses to the trenches, a matter of the utmost practical importance ; or, for instance, in making a screened communication trench up the face of a hill.

A great difficulty is the lack of materials, or rather of the right to 3. Difficulties about Materials. cut and collect them in peace.

It is suggested that the Field Companies should always carry just sufficient materials to mark out in dummy all the work which they would really undertake in war, and for which materials would be available locally. Such materials could probably be carried in the company tool carts, if no tools were carried which were not absolutely necessary. An instance of such dummy work would be tapes fastened to bamboo posts with cards hung on them marked "wire entanglements." The tapes to be exactly the length and in the position where the entanglement would be placed. Wires might be laid to position of land mines, or flares. Enough materials might be carried to make a very short length of a good type of continuous loophole, and overhead cover ; the rest of the trench being marked out with tapes and notices. Notices might be put on loopholed walls, clearings marked out ; notices placed where roads would be blocked, or gaps cut in hedges. A recognized flag might be put on or near all buildings put in a state of defence. In fact, wherever and whatever work would be actually done in war, it should be marked out, and if possible also a sample should be made. A sapper with white bands on his arms can be left to call attention to the notice, and produce a written statement to the umpires of men, time, tools and materials available.

It may be urged that no one will pay any attention to such notices. Perhaps so ; but it might as well be urged that the gunners should

stay at home, because blank ammunition at 3 miles range has often no very marked effect on the course of manœuvres.

The gunners have persisted, and every day we are learning to respect them more !

Moreover the marking out of these works on the ground, if done as the work would have to be done on service, and with proper written statements of time, tools, etc., is by no means an easy thing to arrange, and the companies will certainly learn much by doing it.

4. In Attack. *Infantry Training*, 1911, says :—

“All important points won should be at once placed in a state of defence.

“Such points should be garrisoned temporarily by troops from the rear, so as not to check or weaken the advance.”

This ought to regularly be practised by R.E. in conjunction if possible with the reserves.

As a rule of course the works can only be marked out, but, if well done on a good system, this is excellent practice, and brings in R.E. reconnaissance.

5. In Pursuit. R.E. on bicycles can be sent round to block roads on enemy's line of retirement.

6. Engineers with “Marked” Enemy. Much of the work of engineers on service consists in undoing the work of, or repairing the damage done by the engineers of the enemy. It is very important therefore to always send some engineers with the “marked enemy.”

7. Engineer Reconnaissance. Then there is always the most important duty of engineer reconnaissance. It is well to err here on the side of employing too many rather than too few R.E. of all ranks.

8. Difficulties about Time. On manœuvres, and still more on ordinary field days, it is very difficult to get time to do any real work, even when it is permissible to do it, because battles in manœuvres take immensely less time than in war.

In laying out dummy works credit should be taken for the time which would be available according to the General and Special Ideas, rather than the actual time.

A word of caution however should be said about putting up of notices blocking roads.

It is believed that very great delay could be caused in war by skilfully placed obstructions in an enclosed country like England ; but on field days care must be taken not to upset the cut-and-dried schemes of operations, prepared to meet the very artificial conditions of manœuvres in England.

It is easy to put up notices, but in war there would be great practical difficulties in doing such work and many delays. Therefore more than one notice blocking each road should not usually be allowed on a field day.

A sound practical rule for R.E. work is to estimate the longest possible time taken in peace, and then multiply by two for war.

This question of make-believe works on manœuvres is a very important one.

9. Difficulties
of "Make
Believe."

In nine cases out of ten on field days the engineers cannot do the work which they ought to do in war. If, in consequence, they do not even pretend to do it, but do something else, or perhaps more often do nothing, it is obvious that no progress can be made in the practice of co-operation.

There is a tendency of course, where so much work is make-believe, for the other arms neither to know nor care what the R.E. have done. If this is so the fault really lies with ourselves. If the C.R.E. as well as the senior R.E. officer attached to each brigade or detachment, keeps that close touch with the Staff, which has been so strongly insisted on in this lecture, it is thought this difficulty will gradually be got over, as has happened in the case of the artillery.

In conclusion, gentlemen, it is not too much to hope that the happy day is not far distant when both the Corps of Royal Engineers and all other branches of His Majesty's Service will realize that the engineers exist only for the purpose of rendering the fullest possible assistance to their comrades in every other branch of the Service.

X. — Con-
clusion.

THE ORGANIZATION AND FUNCTIONS OF R.E. UNITS.

By MAJOR G. C. KEMP, R.E.

NUMBERS.

IN the following when numbers are mentioned they refer to war strength. For manœuvre purposes the numbers as regards men may be taken as from a half to a third, more often the latter I am sorry to say.

PIONEERS.

Field Engineers are now recognized as a necessary unit in all modern armies, though in our own this has only comparatively recently been the case. The great Continental armies use them in the form of pioneers: that is, battalions having a proportion of men skilled in trades, the remainder being unskilled men trained as sappers only. During war, however, the company becomes the unit. Our unit is the company both for training and war and fits in with our divisional organization and scattered system of barrack accommodation in peace.

HISTORY.

Although engineers have existed with our armies almost through its history it was in the capacity of directors of works during attack and defence of fortresses rather than as Field Engineers. Until the last 150 years engineers were commissioned as officers with military rank for the campaign only, and the rank and file owes its origin to a more or less unofficial source.

In 1772 a company of soldier artificers was enrolled at Gibraltar for duties connected with the defence of that fortress; the experiment succeeded and gradually the number of the companies increased, being officially recognized under the title of Military Artificers and later as Royal Sappers and Miners. Though employed under officers of R.E. they were a corps apart, being placed under those R.E. officers who happened to be stationed at the same garrison, and there was little continuity of employment between the officers and men.

The companies flourished or languished in sympathy with other branches of the Army during war and peace; they were poorly organized and worse equipped, without proper supplies of tools and

no transport. Until 1812 they received no regular training as sappers, but in that year the S.M.E. was inaugurated and the improvement in their training was immediate and marked; but notwithstanding the great improvement of their training as sappers the defects of equipment and transport still maintained, due chiefly to the 50 years' peace after 1815, and they only suffered in common with the rest of the Army.

The very serious way in which they were handicapped for their duties was recognized during the Crimean War, and, towards the end of that struggle a Mounted Company called the Driver Company Royal Sappers and Miners was formed and sent to the East but it only arrived at Scutari as peace was declared. However, it was the first move towards regularization and mobility; about the same time the anomaly of having companies officered rather haphazard by officers of a different corps was recognized, and the R.E. and R.S. & M. were amalgamated into one corps, very much to the improvement of both.

As a result of the enquiry which took place after the Crimean War into the deficiencies of the Army, it was decided to substitute for the Driver Company the "A" or Pontoon Troop subsequently known as the Bridging Battalion, and a "B" or Field Equipment Troop which consisted of four sections provided with vehicles horses and equipment, the idea being that on mobilization one section would be attached to a R.E. company, converting it from a fortress to a field footing.

In 1877 when matters in the near East appeared threatening the "B" Troop was broken up and four companies converted into Field Companies, and, as a result of the Egyptian Campaign of 1885 the number was increased to 8 and later to 15, at which the number still stands. Of these 12 are for the 6 "Striking Force" Divisions, 2 for S. Africa, and 1 for the Mediterranean.

During the Egyptian Campaign of 1885 a mounted detachment was formed for use with mounted troops, and proved so successful that a Mounted Field Depôt was formed which has now been developed into five Field Troops—four for use with the Cavalry Division and one for South Africa.

After the South African War the Bridging Battalion was disbanded, chiefly from motives of economy, the bridge-making duties devolving on the Field Companies and the material being carried by Bridging Trains forming part of the Army Troops. These are two in number, and each carries sufficient material to form 200 yards of medium bridge.

I have given a very brief account of the development of Field Troops and Companies in order to point out how very recent is our present organization, at present untried in an European war, but modelled as most suitable to the divisional system.

MANUALS.

The result of this very recent development is that outside the Corps the organization and uses of the Field Units are very generally ignored ; it is only within the last few years that Field Companies and Troops have been permanently attached to divisions and participated with them in training in the field and in manœuvres. Another result, and this also reacts on the lack of knowledge of their use, is that unlike other branches of the Service, we have had up to the present no textbook for R.E. training. We have Engineering Manuals which, however useful, throw no light on how and when R.E. should be used. *Combined Training* and *Field Service Regulations* necessarily cannot go into any detail, though even in the *Field Service Regulations* I think we are rather left in the cold. This, however, is shortly to be remedied, a comprehensive Training Manual for R.E. is on the stocks.

TRAINING.

You have, I believe, seen here something of the training of the raw material of which our companies are made up. How he is first trained to be an infantryman, then trained as a sapper, in addition to these two qualifications he is a tradesman, making him particularly useful in carrying out the duties he may have to perform on service.

These various duties are fully kept up when he joins his service unit ; he undergoes annual company trainings in field and technical employment and he also practices his trade on the public works.

What I want particularly to point out is, that although a tradesman, he is also an efficient infantryman, trained in Field Engineering duties and frequently has to perform infantry duties.

ORGANIZATION OF FIELD TROOPS.

The four Field Troops in England are each attached to one of the brigades of the Cavalry Division, and on service come directly under the orders of the C.R.E., Cavalry Division.

Personnel.—Each troop is commanded by a captain with two subalterns, and consists of :—2 staff-sergeants, 2 sergeants, 41 rank and file sappers, 30 drivers. As the troops must be mobile to keep up with the Cavalry Division half the sappers are mounted and half carried in light spring carts.

Trades.—In the *personnel* are included two field line telegraphists, and one office telegraphist for tapping telegraph and telephone lines and for making temporary repairs. Of the remainder, nearly one-third are carpenters, one-seventh blacksmiths, and smaller proportions of bricklayers, masons, fitters and turners, painters, plumbers, collar-makers, wheelwrights, tailors, shoemakers, etc.

Vehicles.—The total number of horses is 81 and of vehicles there are :—2 double tool carts, 2 spring wagons, 1 boat wagon carrying 2 collapsible boats and superstructure, 1 G.S. wagon, 1 bicycle. In addition 5 pack horses carry part of the equipment.

Tools.—In the tool carts are stored entrenching and cutting tools, a few artificers' (carpenters and smiths) tools, water supply plant (one pump and one trough to each), explosives, rations, and miscellaneous stores, such as cordage, nails, bolts, camp kettles, ground sheets, etc.

The spring wagons are mainly for carrying the men, but also carry the telegraph and repairing apparatus and some rations.

The G.S. wagons carry miscellaneous stores, rations, ground sheets, Q.M. stores, etc.

The collapsible boats are tripartite and can be used as boats or formed into raft for the transport of men field guns and light vehicles, not for horses which can swim.

As regards entrenching and cutting tools, enough are carried to supply two working parties each about 20 men strong ; the amount of explosives carried is 280 lbs. of wet guncotton with a proportion of primers and detonators.

Sections.—The troop is divided into two sections, each having approximately equal numbers of tools and stores ; the boat wagon and G.S. wagon belong to No. 1 or Headquarter Section.

FIELD COMPANIES.

Two Field Companies are amongst the Divisional Troops under a C.R.E. This is not a convenient number ; three would be much better, but the number was fixed some years ago when there were only two infantry brigades to a division, and, when a third brigade was included, from financial and possibly recruiting reasons the number of Field Companies was left at two.

The growing tendency to attach a Field Company to a leading brigade, or to a flank or detached column, accentuates this awkward number ; there certainly ought to be three Field Companies with each division, in the same way as there are three brigades of artillery ; not that they should be permanently attached to the infantry brigades, but so that each brigadier may be furnished with a complete Field Company with all its material if necessary. The advantages of three are so obvious and have been so often advanced that it is possible the third company will ultimately be conceded—whether the total number of sappers will be much increased, however, seems more doubtful.

As the companies have to keep up with an Infantry Division, sappers are not mounted or carried ; they have to march, but on an emergency when rapid transit is required a few can be carried on the tool carts or the pontoon wagons for short distances ; 32 also can be mounted on bicycles when such can be used.

Personnel.—Each Field Company is commanded by a major with a captain and 4 subalterns, all mounted. The dismounted portion consists of :—1 staff-sergeant, 5 sergeants, 150 rank and file. In addition there is a mounted staff-sergeant, 1 mounted sergeant, 56 mounted rank and file. There are 73 horses all told.

The company is divided into 1 headquarter and 4 sections each commanded by a subaltern. The headquarter consists of company staff and bridging equipment. Each section consists of 1 sergeant and 36 rank and file.

The trades are practically in the same proportion and of the same nature as for field troops.

Vehicles.—Vehicles are as follows :—With headquarter—1 G.S. wagon, 2 pontoon wagons, 1 trestle wagon. With each section—1 double tool cart, 1 forage cart, 1 pack horse, 8 bicycles (if the country is suitable).

The above are all 1st Line Transport, the only 2nd Line vehicle is a water cart.

Tools.—Each section carries in the tool cart and forage cart and on the pack horse, enough entrenching and cutting tools for two parties of about 20 men, enough carpenter's and smith's tools for hasty work, some 150 sandbags and about 140 lbs. of guncotton and primers, with detonators and exploders. It also has a lift and force pump and a 600-gallon waterproof trough, camp kettles, tackle, cordage, bolts, screws, reserve ammunition, etc. The idea being that so far as weight behind horses allows, each of the four sections shall be independent, and can be detached at once complete in all respects. The G.S. wagon contains Q.M. stores, and special stores and material—signalling apparatus, farriers' tools, veterinary chest, survey instruments, field forge and so on.

Bridging.—The pontoon and trestle wagons are six-horsed vehicles, and carry two bipartite pontoons, two Weldon trestles and enough superstructure to make a medium bridge 75' long, *i.e.*, sufficiently strong to take infantry in fours, field guns, and ordinary G.S. wagons loaded. The bridging material can also be used to make one raft and two trestle piers, if the river to be crossed is so wide as to necessitate ferrying.

Marching.—It is laid down in *Field Service Regulations* that only such vehicles as are immediately required should accompany the troops on the march—all others will be with the 2nd Line Transport. The new engineer training is more precise and only relegates the bridging wagons to the 2nd Line Transport. But bear in mind that much of the bridging material may be very useful to cross a temporary obstruction, even if there is no water, that trestles and superstructure can be used on land when other material is not procurable, and therefore when close to or following up the enemy it is advisable to have the bridging wagons well to the fore.

Half-Companies.—There is a small point I should like to bring to notice, and that is that the Field Troops and Companies are divided into sections and not into halves. I have often seen in orders a half Field Company attached to a force. If two sections are told off, the O.C. knows at once that Headquarters is not intended by the G.O.C. If the Field Company less two sections be told off, he then knows that the Headquarters are intended to go, but if a half Field Company is mentioned, he does not know whether the bridging and special material is required or not. The same applies to the Field Troop.

From the foregoing you will have gathered that a Field Troop or Company only carries sufficient tools for its own immediate use, the transport must necessarily be cut down as low as possible, and they carry no reserve for use by other units. Their numbers too are comparatively small; in the cavalry the proportion is only 1 to 55 of other units, and in an Infantry Division the proportion is 1 to 60 of other units, *i.e.*, 2 per cent., but the cavalry pioneers are available to help the Field Troops. In the Japanese Army in Manchuria the proportion was 5·5 per cent. and this was found all too small, I believe the proportion now is nearer 7 per cent.

SCOPE.

I have been asked to touch on the “scope” of the Field Units. This is, to my mind, very intimately bound up with their co-operation with other arms—but this is the subject of another lecture, as is also the duties during an advance and retreat.

I confess I find it particularly difficult to quote you in man-hours what the Field Troops and the Companies can carry out, for this reason, that I must assume some general average condition which may be extremely misleading if applied to special conditions, and these conditions may only become perceptible after the work has been commenced or the order given.

Now I am inclined to think that your best guide will be the most experienced R.E. officer present who has actually seen and reconnoitred the work proposed or has had reliable reports as to its extent and nature, and who will be in a position to know the actual physical state of the men, their number, the available stores, and what material can be procured locally.

RECONNAISSANCE.

The duties of the R.E. cannot, I think, be more clearly, yet concisely, summarized than in the definition adopted by a recent committee, *i.e.*, “*To apply engineering science to the emergencies of modern warfare in order to protect and assist troops, to ameliorate the conditions under which they are serving, and to facilitate locomotion and communication.*”

This is a very broad definition, and applies to all the various

descriptions of R.E. units ; but it also applies, I think, with special emphasis to the duties of those sappers who accompany that portion of the army on whom the brunt of the active operations falls. For you must remember that the C.R.E. is only human ; he is neither endowed with a flying carpet nor can he project his intelligence to obtain accurate information as to what lies beyond his material eyes, he can conjecture and reason it is true, but he needs confirmation, and this can only be gained by actual reconnaissance either by himself or his officers.

All that is laid down in *F.S. Regulations* to guide the commander as to reconnaissance, equally applies to his C.R.E., who cannot fully back up his G.O.C. with engineering details unless he has a clear notion of what duties he may be called upon to tackle and to prepare as far as lays in his power, to carry out the same.

In the same way as the cavalry are the eyes and ears of the Army, so are the Field Troops to the R.E. Going on ahead with the Cavalry Division, it is their duty to send back to the next most advanced unit information as to what topographical and structural difficulties are likely to be encountered, and, as they spread over a large frontage much useful information as to the whereabouts of water and material can be secured. •

But this is not enough. The Field Troops are, after all, small in numbers and with none too many officers, and both horses and men have their limits of endurance and their own special duties, so that this advanced information will be rather general. The Field Companies with the Infantry Divisions must also develop their Intelligence Department. Whether in an advance on the march or on the battlefield, some officers should accompany the M.I. or cavalry of the A.G. on reconnaissances and convey back information as to how the difficulties can be best overcome or what opportunities exist of facilitating and securing the advance of the army.

For instance I think a G.O.C. or brigadier would be justifiably annoyed if, during the advance to the attack, his artillery was hung up by some impassable ravine or river and that when the sappers were called upon to meet the emergency there was delay in finding the best place to cross and the requisite materials. This sort of difficulty can often be anticipated by intelligent reconnaissance by the Field Company officers.

I must beg you to keep in mind the numbers at present available. At the commencement of a campaign, there are only 160 sappers with the Cavalry Division and 300 with each Infantry Division, or about 2 per cent. of other units. This shortness of numbers tends to emphasize the need for reconnaissance, because in addition to the actual performance of the work, exists the necessity for maturely deciding how these few can be distributed with best effect to economy of labour and time.

WORK IN CAMP.

The Field Troops and the Field Companies in camp must co-operate with other troops to obtain the security of the camp, they must provide facilities for ingress and egress to the camps or billets, arrange and regulate the water supply (this also may apply when on the march), co-operate with the medical authorities with regard to sanitary precautions and hospitals, possibly undertake urgent repairs or supplement details as regards railways.

Water Supply.—Judging by what one sees and hears on manoeuvres in England, I think it as well to give you a few details as to our facilities in dealing with water supply. The Field Companies each carry four pumps and four 600-gallon troughs. Unless there is a municipal or private water supply these pumps have to provide for both drinking water and horses. Now water will not run uphill, so the troughs must be placed on level ground or the ground made level for their reception—ideal sites are rarely found. Given the best possible arrangement, not more than about 250 horses can be watered from each trough per hour, so that with eight troughs down we can water about 2,000 horses an hour. This means that each Infantry Division with horsed transport requires some $3\frac{1}{2}$ hours to get watered.

Supposing that four pumps are devoted to the men's drinking water, each cart takes some 10 minutes to fill, so that to fill up all the water carts of a division takes from 2 to $2\frac{1}{2}$ hours. The actual laying down of troughs and pumps takes only about 15 to 20 minutes; the trouble generally is to get a good site and this sometimes causes delay.

Now you will agree that it is absolutely necessary to have some water supply ready by the time troops file into camp. That means that the Advance Guard Company at least must have its water supply equipment with it, and this must be lifted half an hour before the advance guard moves off, or even earlier if the starting point is some distance from camp. Of course, should local appliances be available, such as pumps, tanks, etc., the lot both of the sappers and rest of the division will be very much improved.

I do not propose to go into the question of water supply and other arrangements when a camp, village or town is occupied for several days; in such cases local arrangements may be available for use, wells may be sunk, streams dammed up, and supplies stored. I only refer to times when the armies are on the move.

Collection of Materials.—Another very serious duty in camp is that of preparing material and collecting transport for work which may lie ahead. I do not advocate trekking along with a lot of stuff on the chance that it may become handy, but it will be rare indeed, especially when getting close to the enemy, that some obstacle will not have to be overcome or some repair made, during the next day's

march. As far as the outpost line, all repairs, alterations, and supplementary communications can be made before the troops start the next morning, but our reconnaissance may bring to light other necessary work beyond, and material must be found and means of transport contrived so that the least delay and confusion may be experienced on the march.

Now, although both troops and companies carry sufficient tools, cordage, lashings, nails, dogs, rods and flats of iron, etc., for repairs, they carry no girders, spars, C.I. sheets, telegraph wire, steel hawsers, planks, hurdles, brushwood, all so useful when road repairs have to be done, so that such requirements must be anticipated. (I exclude the bridging equipment, which is only intended for temporary crossings).

OUTPOSTS.

The sappers, anyhow of the Field Companies, have to foot it on the day's march, and probably have had to put in some strenuous work in addition; they also may have numerous duties in camp. I therefore do not think they should be included in the outpost troops, but, nevertheless, they may have duties on the outpost line. The O.C. Advance Guard Field Company should either himself or by deputy accompany the O.C. outposts or each section of outposts on his preliminary survey of the ground and ascertain where the sappers can assist in the defence of the outposts.

Now on the defensive line of the outposts there will generally be one or two special points which may be termed the key of the position and which require more elaborate preparation than the others, and here sapper labour, so far as regards obstacles, barricades across roads, clearing ground, would undoubtedly be appropriate and necessary, for the time is short and the infantry will generally be fully employed before dark in entrenching themselves, improving communications, latrines, and other necessary work.

On completion of the work the sappers should return to their headquarters.

ATTACK.

The Field Troops would follow the fortunes of the Cavalry Division. Should the latter be able to subdue the opposing cavalry, much of their energy might be devoted to cutting the enemy's communications to the rear, both with a view to hinder possible reinforcements, and to block retreat should the attack prevail. These operations will frequently take the form of demolition with explosives, and here the skill of the O.C. in producing effective destruction with his limited stock of explosives in the shortest possible time will have full effect. Bear in mind that the total amount of guncotton carried by a Field Troop is 280 lbs. only, and to destroy the crown of a brick arch bridge with 18" depth of arch-ring takes some 25 lbs. if tamped, double that if there is no opportunity to tamp.

Strengthening localities to be held as pivots of manœuvre, bridge-heads, etc., cutting railways and telegraph lines, tapping wires, holding up rolling stock, are all duties which may have to be done in the face of the enemy.

The Field Companies' duties during an attack may be to prepare roads for artillery to get into position, crossing obstacles such as a stream or small river in front or on a flank of a position, holding and fortifying rallying points such as farms, woods, hillocks during the advance, erecting field observatories, and helping to confirm a victory by entrenching particular points after a successful attack.

As regards the distribution of the units, I am strongly of opinion, though I know it is not universally held, that so far as possible, units should be kept together intact under the hand of the O.C., and not unduly weakened by being parcelled out in small parties for work with the firing line. To be of use after the assault, the work against counter-attack must be prompt, and should be undertaken where considered necessary on the initiative of the senior R.E. officer. This is not possible if he has to go along the whole front of the units to which his company has been allotted and rally them to some place possibly some distance to a flank. The same applies to assisting the troops in pursuit. Such work should not wait for orders from the Staff, who, however, should be informed of what the company is doing.

As regards such work, a company of 150 men can, in an hour, throw up a number of quite respectable trenches aggregating 250 yards length, and hold them if required. If subsequently occupied by infantry, the latter could improve them while the sappers devoted their attention to other points requiring similar defence. This would ensure co-ordination of trenches, all being under the direction of one man, who could grasp the possibilities and necessities of the situation.

Another most important duty during the attack is to arrange for water supply, not necessarily for the distribution for troops, though that might be necessary on occasion, but to arrange for the water carts to be filled and to get forward over possibly rough ground.

DEFENCE.

It is, I think, nowadays an accepted principle that while the infantry must prepare their own entrenchments, the sappers' work lies in odd jobs—fortifying houses or enclosures, clearing foreground, laying down obstacles and mines, trip wires and flares, organizing the water supply, and preparing material if occasion demands for overhead cover, drainage, revetments, and distributing tools if any.

Clearings.—One sometimes sees on defence problems worked out, vast areas of ground from which trees (on paper) have been removed, and long lines of abattis and wire entanglements out of all proportion to the numbers of troops and time available.

Clearing the front of a position, always a most desirable and often necessary item if time admits, must be carried out in conformity with the requirements of the trenches, the amount which can be cleared depends on the tools available. A Field Company has 12 cross-cut saws and 48 felling axes, also 28 hand axes and 40 billhooks; that means that 60 men can fell while 68 lop. Taking the average tree to be 6" to 8" in girth and to stand 15' clear of all others (the average orchard is 21' apart and woods grow generally somewhat closer), this means that in an hour one man can clear say eight trees covering an average space of 20 yards by 10 yards, and 60 men a space of say 300 yards by 40 yards or 150 yards by 80 yards or about $2\frac{1}{2}$ acres. The men lopping would hardly keep pace and I should feel inclined to reduce the figures to 100 yards by 80 yards of trees ready to be carried away, say from $1\frac{3}{4}$ to 2 acres.

But it is no use leaving the trees on the ground as they are, they only form an excellent cover for the enemy so they must be removed, and to do this, as all the sappers would be employed in felling and lopping, infantry working parties must be employed, about 200 per Field Company, to drag the trees when lopped either to some fold of the ground or to form an abattis.

It is evident from the figures I have given that extensive clearings cannot be made unless ample time is allowed and in woods of any size avenues of 40 yards to 50 yards width should be cut diagonally to the front, commanded by trenches which would fire down the length of them, the trees being piled on the near side to form a kind of abattis.

Obstacles.—Abattis, except as already described, cannot be prepared without much deliberation; other obstacles practically narrow themselves down to wire obstacles, of these the most effective is the high wire entanglement. As all entanglements should be under effective rifle fire the depth need not exceed say 12'. One man will do a little less than 1 foot's length of this in an hour. 150 sappers would thus carry out in an hour about 50 yards of such entanglements, not very much when you come to think of it. Working for 12 hours, it means that a company would be able to complete 600 yards of the 12' width. To entangle 50 yards of ground needs something like $1\frac{1}{3}$ miles of wire and no wire is carried with a Field Company, so that it is no good airily arranging for such obstacles unless previous arrangements have been made to procure materials.

It is recognized that 12' is really too narrow as it can be crossed by hurdles, etc., but wider entanglements such as 25' or 30' wide would hardly come within the scope of hasty defences such as are here quoted, when so to speak one is working against time.

Redoubts.—In a deliberate defence when there is time, redoubts

may be constructed; in such cases the Field Companies must requisition infantry to assist them.

In the Japanese Engineer Manœuvres at Morioka in 1908, a redoubt was the principal object of attack. This redoubt was designed to hold two companies of infantry, *i.e.*, 400 men and one section engineers about 50 men. The total length was 850', greatest depth 300, it had a command of about 4' 3", the ditch was nearly 10' deep and the width at top 19', and there was a good deal of wire entanglement. This redoubt was completed in 28 hours, but a good many details such as joining up connections were carried out afterwards. The shelters were not very elaborate, six men lying down were supposed to occupy only 6' x 8', and only part of the garrison were provided with shelter. The number of men-hours taken was 14,700 roughly. The number of men employed is not very clear in the report, one regiment of infantry less one battalion and one company of engineers (200 men) were employed on the whole position, but the redoubt constituted the chief position of the defence, and according to the men-hours taken about 2,100 men were employed in each relief of four hours.

This gives a rough guide as to what can be done—a redoubt to hold two companies of British infantry could be carried out by one Field Company and 800 infantry in from 16 to 20 hours.

Other obstacles which may be used for definite situations are hurdles and harrows at fords, iron railings or loosely coiled wire in streams, cutting the banks of streams perpendicular, scarping steep ground, blocking cuttings of roads with heavy trees, destroying embankments, damming up streams. The latter, even if not lasting, would be most effective, if the ground near the bank can be well soaked and rendered marshy.

Bridging.—As I have mentioned before neither Field Troops or Companies carry the main essentials for spar or suspension bridges; these would have to be obtained locally, from the A.O.D., or from the base. Each company has, however, pontoon bridging equipment for 75' run, in addition to this the Bridging Train provides enough for 200 yards and would be brought up should a considerable river have to be crossed. The men of the Field Companies are trained in pontooning, one company at full strength should be capable of constructing the bridge though of course two companies would quicken the operation.

The time required would depend very much on the site—whether the pontoon wagons can be got easily to the banks and the manner in which the bridge be made; these will depend a good deal on the tactical conditions. For instance, it will be quicker to build the bridge by swinging than by forming up, but it requires a stretch of good bank, or it may be necessary to construct the bridge considerably higher up the river and float it down either whole or in parts.

In small bridges which the company can carry out with its own equipment, the time generally depends as to whether trestles must be used or not, and if so on the nature of the bottom. They are kittle cattle and generally give the unfortunate sapper away badly by getting one leg into a hole. The pontooning portion would only take from 15 minutes to 20 minutes. At Spion Kop the Bridging Battalion built a bridge about 240' wide in two hours. At Vaal Krantz 210' were spanned in 50 minutes under fire, the bridging Battalion and two Field Companies were engaged on the work. In the 1909 Aldershot Divisional Inspection two companies at peace strength, total about 100 men, bridged the Thames at Henley in about two hours, width about 220'.

As regards other bridges I will quote a few instances which I have found recorded, of times taken to construct bridges in the Chitral Campaign of 1895. An extraordinary number of bridges of various sorts had to be made and though the labour was the native Sappers and Miners, I do not think, except in one or two cases, that their work was inferior to our own sappers. In some of the cases the work was delayed because material had to be prepared at site, and as the Sappers and Miners enlist only a proportion of tradesmen, the work was necessarily slower than it would be with Field Companies.

Trestle Bridges.—The Swat trestle bridge was 1,350' long, made in water averaging 2' to 5' deep, arranged with one crate to three trestles; later four-legged trestles were used. The material was entirely procured from neighbouring villages, using rafters and doors. Two companies worked on it for eight days, which gives 85' length per day to each company.

Another bridge made in the same way was 240' long; half was made from material floated from a village, some miles up stream, and the other half sawn from logs found about a mile below the site, there were no proper saws, sawpits or trained sawyers. It took 66 men, or say two sections, seven days, but probably four would have been enough if material had been found ready to hand.

Over the Little Tugela, at Spion Kop, a trestle bridge about 130' long, the river being about 5' deep and running 3 miles per hour, was built between 9.15 p.m. and 8 a.m.—10 $\frac{3}{4}$ hours, but the material had been previously prepared. One Field Company worked on it.

Suspension Bridges.—The old Pangkora bridge. Span 90', cables made of five telegraph wires bound together. Took one company of 120 men with the help of 150 infantry 2 $\frac{1}{2}$ days; the approaches had to be blasted and cleared. The second Pangkora bridge, also made of telegraph wire, was 192' span. It took 55 to 60 men 10 days to complete.

Another suspension bridge at Chutiatan, made with cables and

with span of 70', occupied about 70 men 10 days. I think, however, the latter days were of eight hours, all the former examples of 11 or 12 hours.

Our duties in war are heavy and numerous, our numbers small, and when large and important works are necessary we need help from other arms to carry them out; unfortunately on peace training and manœuvres much of our work has to be left to the imagination, but I believe that our present system of training together will result in that help being given ungrudgingly and freely when required.

R.E. SIEGE AND FORTRESS UNITS WITH REFERENCE TO FORTRESS WARFARE.

By MAJOR J. C. MATHESON, R.E.

IN addition to Field Troops and Field Companies and various units of a more technical description which are intended to minister to the wants of an army in the field, the Corps of Royal Engineers possesses 30 so-called "Fortress" Companies scattered over the Empire, 15 at home and 15 abroad, which are primarily intended for what we may call the *points d'appui* of the Navy.

These may be classified as follows:—

- (i.). For Electric Light duties only:—2 at home, Portsmouth and Plymouth; 4 abroad, 1 each at Malta and Hong Kong and 2 at Gibraltar.
- (ii.). Partly for Electric Light duties and partly for "Works" duties:—At home, 11; abroad, 7.
- (iii.). For "Works" duties only:—2 at home, Portsmouth and Plymouth; 4 abroad, 1 each at Malta and Hong Kong and 2 at Gibraltar.

There is no common establishment for these companies, they vary according to the duties which are required of them in each station.

As regards Class (i.) the establishment is decided by the number of lights to be run by the company. Abroad, the company must run all the lights by itself, it can expect no help from auxiliary forces. The establishment is decided by allowing 10 men per light and these 10 must supply all the labour necessary in the emplacement and the engine-room, furnish the required company duties such as cooks and cook's-mates and also be able to provide two reliefs for the lights, that is one on and one off.

At home the companies get help from the Territorials. In the precautionary period the Territorial units which have been formed at the coast fortresses where there are lights furnish Special Service Sections which at once mobilize. On mobilization the whole of the Territorial unit will be available to assist, and, to give a good margin, their establishment has been calculated at 50 per cent. higher than is actually required. The numbers required for running lights at home is also based on the 10 men per light of which 6 are supposed to be Regulars and 4 Territorials. At home the war establishment of the

companies is the same as the peace except in the case of Portsmouth and Plymouth where 40 reservists join each E.L. Company.

In addition to the care and maintenance of the electric lights, these companies abroad have practically the whole of the construction, maintenance and working of the electrical communications to look after. At home the question is complicated by the fact that the Post Office does a certain amount, but the companies have a great deal to do with these essential electrical communications.

In almost all cases the lights are in permanent emplacements, it is only exceptionally that there are movable (one cannot say mobile) lights in the fortresses.

These companies have incessant practice with their lights and also have to go through a course of military engineering annually, in addition to musketry.

As regards Class (ii.) the electric light portion of the companies is calculated upon and works in the same way as those of Class (i.). But these companies have also a portion who are not intended for electric light duties but for field military engineering. They have no equipment of tools or transport, these must be obtained on movement and the defence scheme of the fortress contains the numbers required and whence they are to be obtained.

During the precautionary period the work of these men will be in connection with the defences of electric lights, directing stations, naval signal stations, cable landings, position finding stations, coast batteries, waterworks, etc., also the land fronts of coast fortresses.

The military engineering annual course for Fortress Companies is the same as that for Field Companies with the omission of pontooning.

Class (iii.) consists of companies which are meant for field engineering duties only, within the *ravon* of the fortress in the same way that the works portions of the Class (ii.) units are. Four out of these six companies are abroad, and in their case it should be noted that in the event of any force being moved out of the fortress in which these units are, they must be prepared to take up the duties of Field Companies for that force, as, for instance, the 25th Company, R.E., from Hong Kong in the Pekin Relief Expedition of 1900.

The establishments of the companies of Class (iii.) vary from 60 to 171 according to the requirements of their particular stations.

Two companies of Class (iii.) are stationed at home and to them has been allotted a special *rôle* in addition to their ordinary duties. The British Army is trained to fight according to civilized methods and this includes fortress warfare either in connection with a permanent fortress or with one improvised during the campaign. For a long time we have had artillery units specially trained in this branch of warfare and now two companies of the R.E. have been ear-marked as Siege Companies. At the present time they possess no special equipment but every year they go through a course of military engineering

designed to exercise the men in the several duties appertaining to engineers in fortress warfare.

It is impossible in the time available to say much on this subject of fortress warfare. I would merely try to present one aspect of it to show the necessity for thorough co-operation between the infantry and the engineers.

During the decade after the Franco-German War the great developments in war material inclined many minds to the opinion that such an operation as a formal siege was a thing of the past. This seems to have been due to a very prevalent misconception, viz., that inventions and improvements "revolutionize warfare." I do not think that this has ever been the case. Methods of warfare certainly *change* on account of improvements in and additions to war material, but "*revolutions*" do not take place. So far as fortress warfare is concerned this was demonstrated by the Siege of Port Arthur. Assaults by main force on the fortress failed, and little progress was made by the Japanese until the old methods of regular siege were adopted, modified in details as required by the circumstances of the period.

But although the siege was a modern one, in details the fortress was very inferior according to present ideas.

More and more, permanent fortification, as well as field, has fallen under the influence of the "offensive" spirit. We cannot now be content to place a physical obstacle between the enemy and ourselves, we must damage him as well as keep him from damaging us.

But in the case of a force garrisoning a fortress, actual offensive movements against the besieger cannot be on a large scale, they must be confined to small field movements, calculated to harass and annoy the enemy as much as possible, and to counter-approaches. This is because of the isolation of the garrison and its daily irreparable waste.

Thus actual action against the besieger must be by fire principally and the modern fortress must provide every possible facility for this fire. It has therefore come to pass, after many developments that the old forts, which formerly constituted by themselves the *points d'appui* of the defensive position, now only form a portion of them. They are intended to act as supporting points, while they themselves are surrounded by a large perimeter of emplacements for infantry fire.

The main artillery of the fortress is now always divorced from the forts themselves, although flanking guns may still often be found there. This is a principle accepted by all nations. The modern conception of a fort may best be illustrated by a diagram of one of the new works at Metz. This diagram, which does not pretend to be an accurate plan, is taken from a French work by Colonel Piarron de Mondesir, to whom I am indebted for permission to reproduce it.

APPROXIMATE DIAGRAM OF THE METZ FESTE.

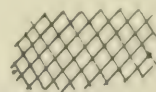
REFERENCE.

- Fort, with deep ditch and armoured light Q.F. and machine guns A
 Armoured battery for direct-fire guns B
 Armoured battery for indirect-fire guns C
 Bombproof shelters D
 Emplacements for movable cupolas E

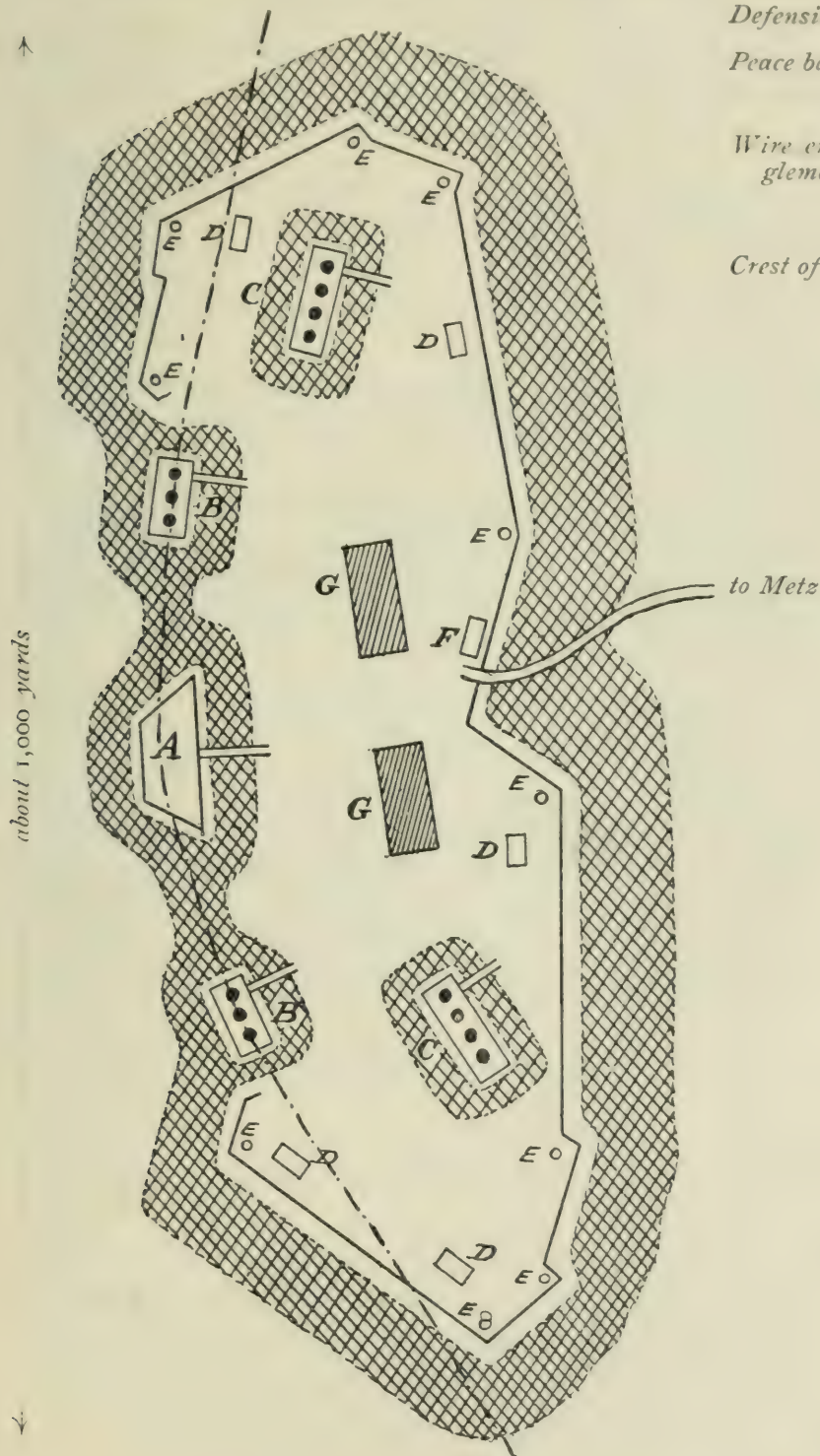
Defensible guardhouse F

Peace barracks G

Wire entanglement



Crest of slope - - - - -



The points about this type of work which seem worthy of note are :—

- (a). The central supporting work which is here placed on the crest. In France the rear position is advocated.
- (b). The batteries for direct and indirect fire. The question of whether the guns are provided with armoured protection or not appears to be principally one of detail. Armour is only one form of protection.
- (c). The large extension of the infantry perimeter.
- (d). The provision of a deep ditch round the central work and the wide belt of wire entanglement round the whole work.

These satellite fortresses, as they may be called, are very much advanced from the old works and would lengthen largely the line of investment.

A French view of the modern tendencies of permanent fortification is given by General Langlois as follows :—

(1). The perfection of firearms, especially the rifle, has given to field fortification an extraordinary power of resistance, due to the fire, not to the obstacle.

(2). These light fortifications escape to a great extent the effects of the artillery of the attack not because they are so strongly built but because they are so extended. They present so great a surface that, to break down the defence an enormous amount of ammunition would be required.

(3). Permanent fortifications (as generally understood) on the contrary, consisting of forts of high profile but of small area can offer only a feeble resistance to large shells, charged with high explosives. The strength of resistance lies more in invisibility and in extension of numerous and relatively feeble objectives than in the accumulation of concrete and armour. For the latter an engine of destruction will always be found which will get the better of them, they have never more than a transitory value and do not justify their expense.

(4). In short, permanent fortification is becoming very much like field fortification.

The latter sentences, as to the value of forts, as generally understood, are distinctly sweeping and too revolutionary for the present day. The forts at Port Arthur, conspicuous, inferior and unfinished as they were, did yeoman service and the flanked deep ditch proved itself unequalled as an obstacle. It certainly seems that forts of strong profile, with deep ditches and strong casemates will still be able to play a part in the modern fortress when properly sited as the nucleus of a *point d'appui*. That site would appear to be on the rear slope and not on the crest. The physical and moral

support possible from such a work must be of the greatest value, and in many cases opportunity would be given for placing in the fort those flanking guns which are of such great service in the close defence.

Although these are recent ideas on permanent fortification it must not be supposed that many fortresses are organized fully according to these lines. Fortresses cannot be in a constant state of alteration, expense forbids, so that in most cases new ideas can be applied only partially, but it will be observed that this recent development is fairly simple in its application, in that it consists to such a large extent of field fortification. In this connection also it is well to bear in mind that splendid defences have been made behind works which have been considered out of date. A fort is not necessarily valueless because it is old.

This brief account of the modern tendencies of fortification has been given to bring out the point that, as the defence works have developed, so it is necessary to extend the works required to prosecute the siege.

In the attack of a modern fortress, which is really a strongly fortified defensive position without flanks, there comes a time when the defenders have been driven into their works, and further progress in the open by the attackers becomes impossible.

Some means must then be devised to enable the attacker to neutralize the enormous advantage possessed by the defender of a prepared clear field of fire, swept by strong fire frontal and flanking. The only way to do this without excessive loss is to dig covered paths up to the defenders' works and so allow the attacking infantry once more to close with their adversaries on approximately equal terms.

This has always been the ruling idea of a regular siege and it is only in details that we differ from our fathers. For instance sapping must now start further back than formerly. It can now, as a rule, be done in hours of darkness only. In old days a movable covering head could be used for saps ; now the effect of modern firearms is such that this cover is hardly good enough, and so we resort to a sap which is very narrow and has no parapet. It is thus practically invisible and the sap-head, *the* vulnerable point, can progress. As the sap advances it is not so important to conceal the portion already made as the great length of trench forbids concentration of fire against much of it.

When the large front of fire line of the defence is considered and the distance from which approaches have to start, it is evident that a very large amount of labour will be required to make these covered paths. At Port Arthur there were nearly 17 miles of approach and parallel and 640 yards of mine gallery. These were not made without loss. In the construction of these works the Japanese lost

nearly 2,000 infantry and 1,000 engineers. It must be remembered too that the front of attack at Port Arthur was less than 2 miles.

The greater portion of the parallels and approaches will have to be sapped. In the British Army in peace time sapping and mining are practised by the R.E. only. But in war their numbers will never be sufficient for the amount of work to be done. We must get help and a large amount of help from the infantry, at all events in the sapping if not in the mining.

Although the two Siege Companies, R.E., are specially trained in this kind of work, it would hardly be advisable to use them to any great extent in the early parts of the siege. Sapping in the later stages and mining, with its modern developments, *e.g.* bored mines, is a more technical task than the earlier work, and it might be the wiser plan to keep these specialized units for this more difficult work for which they are prepared.

Thus fortress warfare is by no means a matter for R.A. and R.E. only. The infantry as usual is the principal arm. In the earlier stages they will have to fight for the advanced positions and be experts in rapid methods of entrenchment. Then they will certainly have to assist in the construction of the covered approaches up to the enemy's works, while in the final stage all the work of gunner and sapper has been undertaken for the object of enabling the infantry to deliver the assault on the enemy on at least equal terms and with good hopes of success.

THE EMPLOYMENT OF FIELD COMPANIES IN THE IMPROVEMENT AND DESTRUCTION OF COMMUNICATIONS.

By CAPT. C. E. P. SANKEY, R.E.

INTRODUCTION.

IN addition to various specialist troops, such as Wireless Telegraph Companies and Railway Companies, there are three classes of unit available for carrying out the miscellaneous engineering work required by an army in the field; these three classes differ in their relative proximity to the enemy, and, in the inverse order, in the magnitude of the work with which they are able to cope.

In the first place is the Field Troop, co-operating with cavalry and therefore presumably well in advance; this unit cannot furnish a large working party nor does it carry very much in the way of tools and materials: what is still more operative in limiting the scope of its employment is the fact that it is attached to troops capable of rapid movement and therefore must not be immobilized too long at one piece of work, for fear of losing touch with such troops. Limited though its own powers of work may be, its *personnel* would undoubtedly carry out much useful engineer reconnaissance for the information of the other classes of unit further behind.

The next unit to be considered is the Field Company; this class operates with the main infantry forces and is in an intermediate position as regards both considerations. It has more men, tools and materials than the Field Troop, and can be kept for a longer time at one job without the risk of losing touch with the slower moving infantry.

In the third place is the Works Company, on the Lines of Communications; though not in itself very strong numerically, it contains an organization for directing a considerable amount of civil labour, and for handling large quantities of tools and materials. It is equipped with field workshops and a good assortment of tools, and may be considered capable of dealing with any engineering work of reasonable size.

Although the Field Company is the immediate subject of the present investigation, the following remarks can be made applicable, by suitable modifications, to the two other classes of unit.

THE FIELD COMPANY.

It is not proposed to examine the organization and equipment of a Field Company very closely : not only would this partake too much of the wealth of technical detail that it is desired to avoid, but it would also have a tendency to lose sight of the important power that the unit possesses of alteration and expansion in both particulars. For the present purpose therefore, the term "Field Company" will be taken to mean a working unit, consisting of about 150 hands, already divided into four detachable sections, and capable of further subdivision into smaller gangs, provided with superintendents and gangers in the persons of the officers and N.C.O.'s. These smaller gangs would as a rule consist of the units of military organization, the group and the squad, but it is conceivable that the section commander might sometimes find it desirable to subdivide his section according to the trades of his men, because this working unit is more than a collection of organized labour ; all its individual members are tradesmen, that is, each man is a specialist at some form or another of technical work.

It depends on the nature of the work to be executed whether or not all these men can be employed at their trades : in a complex job, it would probably happen that the majority could be so employed, or at least, employed at a trade of cognate nature ; in a simpler job, though by this is not at all necessarily meant a smaller job, it will probably not be possible so to employ them. In such cases, certain of the men can be employed at the form of technical work in which they are specialists, while the remainder, for the time being, will have to act as labourers to them.

This unit, from its organization, is capable of being readily moved from one place to another, and to a limited extent, at a comparatively rapid rate : it is provided with a fair assortment of tools, and carries a small amount of material.

There is another, and a very important, point of view from which the Field Company can be regarded, and that is as a nucleus, with consequent powers of expansion, of men, tools and materials. That is to say, for heavy pieces of work, additional working parties, from other branches of the Army or from civil sources, can be assimilated in its organization ; in most cases, in civilized countries, its supply of tools can be augmented by local resources, and those tools collected by men who know just what they want and where they are likely to be found ; and for material it will have very largely, if not entirely, to depend on what can be found in the district, and in this direction also the technical knowledge of men of appropriate trades will be most valuable.

COMMUNICATIONS.

An unit, constituted in this manner, is capable of carrying out many varieties of engineering work, but the present investigation is limited to the question of the improvement and destruction of communications. It will readily be seen that these two subjects are intimately and inextricably connected, and are in fact, the two opposite aspects of the same problem ; it is proposed therefore to deal with them concurrently.

The subject might be considered from many points of view : it would be possible to consider the tactical aspect, but this, though of the greatest importance, would not be suitable here ; on the other hand, it would be possible to discuss a mass of highly technical details connected with such operations, a procedure that would be equally unsuitable. The present proposal is to look at the question in broad technical outline, showing the type of work that such an unit might be called upon, and which is within its powers, to perform ; at the same time it is proposed to point out, and in fact to lay stress upon, the difficulties and delays that are liable to occur in the execution of the work. This latter point is important, because on manœuvres it is seldom possible actually to carry out any work, and hence falsely optimistic ideas are liable to be held about the time necessary for such operations. It has no doubt often happened on these occasions that the time considered necessary for the demolition of a bridge is that required for making and erecting a notice board to that effect, while the bridge can be repaired, even more quickly, by pulling that notice board down. It is true that time, in the majority of cases of military engineering, is far and away the predominant factor, yet, no matter how great the urgency, nor how many men are employed on the work, it is impossible to hurry a job beyond a certain limit ; time is required, firstly for the collection of material, and then for its utilization. Moreover, accidents that have neither been, nor in fact could have been, foreseen, may very largely increase the time that normally should be required ; a defective link in a chain sling may drop a girder during its erection ; an unsuspected mudhole in an apparently sound river bottom may swallow up the leg of a trestle ; these, and other similar cases, will waste many precious minutes and hours.

In order to obtain a comprehensive survey of the types of work that fall within the scope of a Field Company it is proposed firstly to classify the different methods of communications, secondly to indicate how communications can be improved or impeded, and finally, by the combination of these classifications, to obtain an analysis of the cases that are likely to occur in practice.

In the first place then, communications can be broadly grouped into Land Communications and Water Communications, though no

doubt in the near future Aerial Communications will have to be added to the list. These groups can be further subdivided into unconstrained communications, that is to say those that are not confined to a line or lines of comparatively narrow width, and also into communications that are so constrained. The first subdivision of the first group gives movements across country and the second subdivision includes roads and railways. In the second group, the second subdivision alone will be dealt with in the shape of communications along rivers and canals.

As regards the classification of the possible impediments to free communication, in addition to simple offensive action on the part of the enemy, they may be grouped, from the point of view of the side that desires to use the communications, into obstacles that already exist, obstacles that have been placed in position by the enemy, or hostile obstacles as they may be called, and the demolition or destruction by the enemy of facilities to communication that formerly existed. By a transposition of terms, the other side of the question can be studied, and therefore the consideration of the improvement and the destruction of communications will be dealt with at the same time. For this purpose, the analysis shown in Table A has been drawn up, by a combination of the above classifications. It makes no pretence at being exhaustive, but on the contrary is meant to be merely suggestive of conceivable opportunities for the employment of an engineering unit.

ILLUSTRATIONS.

As a further illustration, it is proposed to examine two specimen cases in greater detail, though as before the tactical situation will not be considered.

In the first place suppose that the officer commanding a Field Company, forming part of a retreating force, receives orders to demolish a brick arch spanning a river about 60' wide. Broadly speaking, there are three methods open to him by which to attack the bridge. He can dig a trench across the roadway at the centre or crown of the arch, deep enough to expose the brick arch rings; the gap produced by a charge exploded in this trench would probably not be a very wide one, and the reconstruction of the bridge would not be a very difficult matter. He can dig trenches across the roadway at each end, exposing the arch rings at the haunches; this will give the most complete demolition, and practically the whole of the bridge will be destroyed; on the other hand, it will take more time, as the trenches will have to be deeper, and a greater expenditure of explosives will be necessary, as there are two charges to be made up; it is to be noted that more time is not required on account of there being two trenches to be dug—this merely means that twice as many men can be got to work at once. Finally, he can support a charge

on a board slung underneath the crown of the arch ; this procedure is by no means as simple as it sounds, because the weight of the charge, and the weight of the board itself, will cause such a sag that the charge will not be in contact with the brickwork, and the demolition will probably fail : to make the board stiff enough, it will be necessary to build a more or less complicated truss, with precautions to prevent it warping out of its plane : to obtain material for this, and to construct it, will probably take as much time as is required for the excavation of the trenches, to say nothing of the fact that the charge on the board truss will have to be launched into position, a work of more or less time, depending on the circumstances of the case.

There is, however, a most important consideration that must not be lost sight of, namely that it would hardly be permissible to diminish the available breadth of the roadway for the troops retiring over the bridge, even by digging only one half of the trenches at a time, and thus, as the two digging methods could not be begun until after the passage of the troops, it may possibly be best to construct the timber truss, which can always be made somewhere out of the way, and which, under favourable conditions, may even be placed in position without interfering with the use of the bridge. In any case the calculation of the charge can be made, and the charge itself arranged and made up, so that no time is lost when the work can actually be begun ; the preparations to be made in this way will resemble those of skilful stage management, so that no delay whatever may occur in getting to work as soon as the use of the bridge, as such, is no longer required.

It is not easy, in a hypothetical case, to give even an approximate estimate of the time required for carrying out the various portions of the work : with this limitation in view, it may perhaps be stated that with the timber truss method, at least one and a-half hours would be required to construct the truss, in addition to any time necessary for collecting the material, and that requisite for placing it in position : it would not be safe to reckon on excavating the central trench in less than an hour and a-half, while the deeper trenches at the haunches would take longer still.

As a second instance, suppose that the force in pursuit arrives at the site of the bridge that has been destroyed in the first example, and finds that the demolition has been carried out in a very thorough manner. It may further be supposed that no pontoon equipment is available, and that the officer commanding the Field Company entrusted with its repair decides on a reconstruction by means of a trestle bridge, the river being neither too deep nor too swift for this type ; his unit carries no material for this, but it may be assumed that there is a house in the vicinity from which materials can be obtained. The work of obtaining planking and joists from the floors

of the house can be put in hand at once, and at the same time it will be possible to take a section of the gap, and to make the calculations from which the detailed design of the bridge can be worked out; this will be dependent upon the traffic to be dealt with, and also upon the nature and state of preservation of the material from the house. The material having been collected, the construction of the trestles can be put in hand; here, as well as in the collection of the material, the technical skill of the carpenters and men of allied trades will be invaluable, while it is possible that the blacksmiths and so forth can be usefully employed in the preparation of bolts and other fastenings. The removal of the *débris* and the preparation of the approaches will also have been undertaken from the first, and it then remains to erect the trestles and to complete the bridge.

As before, the estimate of the time required can only be very approximate indeed, but in the most favourable circumstances it would not be safe to reckon on less than one hour for the collection of materials, another for the construction of the trestles, and, in the case of a gap such as this is assumed to be, two hours for the erection of four trestles, two from each side.

CONCLUSION.

It has not been possible to give more than a very hurried survey of the different forms of employment for a Field Company in connection with communications, but enough has been said to show that cases of a very varied nature may arise, and that a Field Company, from the diversity of trades represented among its members, is very well suited to deal with them.

TABLE A.

COMMUNICATIONS		HOW IMPEDED	AND	IMPROVED.
<i>LAND.</i>				
<i>Unconstrained.</i>				
Movement across country.	<i>(A). Existing Obstacles.</i>			
	(1). Rivers and canals	...	...	(a). Simple bridges. (b). Floating bridges. (i.). Bridge Train. (ii.). Boats, barrels, etc.; material to be collected. (c). Trestle bridges. (d). Other types. Apt to be beyond scope of Field Company.
	(2). Dry ravines	...	...	(a), (c), (d) as above.
	(3). Enclosed and cultivated country.			Gaps cut in fences and hedges.
	(4). Wooded country	...	...	Paths cut through woods.
	(5). Swampy country	...	...	Corduroy roads.
	<i>(B). Hostile Obstacles.</i>			
	Entanglements	...	...	Removal.
	Abatis	...	...	Co-operation if under fire.
	<i>(A). Existing Obstacles.</i>			
<i>Constrained.</i> I. Roads.	Road too narrow	...	...	(a). Widening. (b). Crossing places.
	<i>(B). Hostile Obstacles.</i>			
	(1). Passive, as felled trees	...	...	Removal.
	(2). Active, as barricades	...	...	Attack and removal. Co-operation.
	<i>(C). Demolition.</i>			
	Bridges destroyed	...	...	(a). Reconstruction, as above.
	(i.). Explosives	...	...	(b). Deviation.
	(ii.). Burning.			
	<i>(B). Hostile Obstacles.</i>			
	Obstruction on line	...	...	Removal.
II. Railways.	<i>(C). Demolition.</i>			
	(1). Bridges destroyed	...	...	(a). Reconstruction. (b). Deviation. Heavy trestles.
	(2). Tunnels blown in	...	...	Clearance.
	(3). Rails, etc., removed	...	...	Renewal.
	(4). Rolling stock removed	...	...	Specialist work. Replacement.
	<i>(A). Existing Obstacles.</i>			
	(1). Sandbanks	...	...	Dredging. Slow work.
	(2). Floating vegetation	...	...	Passages cut.
	(3). Overhanging trees	...	...	Branches cleared away. Towpath may be necessary.
	<i>(B). Hostile Obstacles.</i>			
<i>WATER.</i> <i>Constrained.</i> I. Rivers.	(1). Booms and dams	...	...	Removal.
	(2). Mines	...	...	Removal.
	<i>(A). Existing Obstacles.</i>			
	Overgrown or filled up through disuse.			Restoration.
	<i>(B). Hostile Obstacles.</i>			
	As for Rivers	...	...	As for Rivers.
	<i>(C). Demolition.</i>			
	(1). Lock gates destroyed	...	...	Renewal. May be a long job.
	(2). Banks pierced if above land level.			Repair.
	<i>(A). Existing Obstacles.</i>			
II. Canals.	Overgrown or filled up through disuse.			Restoration.
	<i>(B). Hostile Obstacles.</i>			
	As for Rivers	...	...	As for Rivers.
	<i>(C). Demolition.</i>			
	(1). Lock gates destroyed	...	...	Renewal. May be a long job.
	(2). Banks pierced if above land level.			Repair.

SYNOPSIS OF LECTURE ON "THE ARMY SIGNAL SERVICE."

By CAPT. H. CLEMENTI SMITH, R.E.

THE "Signal Service" is carried out in the field by :—

- (i.). Units of the Army Signal Service.
- (ii.). The "Signal " *personnel* of other units.

All ranks should assist to keep the means of communication intact.

1.—The Army Signal Units are :—

On Line of Communication—

The Line of Communication Signal Companies.

With Army Troops—

- 2 Air Line Signal Companies.
- 2 Cable Signal Companies.
- Wireless Signal Company.

With an Infantry Division—

A Signal Company (which includes 3 sections for each Infantry Brigade).

With a Cavalry Division—

A Signal Squadron.

With a Cavalry or Mounted Brigade—

A Signal Troop.

The Line of Communication Companies can be varied to suit local requirements and also have a Railway Section.

Air Line Signal Companies.—Of which there are 2, have 3 sections each of 2 detachments.

Each detachment has 10 miles of air line and 2 second-class offices, total 60 miles and 12 offices. It also has 3 cable wagons with 24 miles of cable and 6 vibrator offices, but no *personnel* for these.

They are used for communication between General or Army Headquarters and the advanced base.

Cable Signal Companies.—Of which there are 2, have 4 sections each of 2 detachments and 1 extra detachment; each detachment 10 miles of cable and 3 vibrator offices. Each detachment has a light spring wagon for its transport.

Total 90 miles, 27 offices, and also 13 motor cyclists for despatch riding purposes.

They are used for communication between General Headquarters and Army or Division Headquarters as required.

The unit for employment in both Air Line and Cable Companies is the section of 2 detachments. The Headquarters of the companies provide the *personnel* for administrative purposes at General and Army Headquarters.

Wireless Signal Company.—Consists of 3 long distance wireless stations (80-mile radius) and 9 motor cyclist despatch riders, and is used for communication between General Headquarters and Cavalry Division Headquarters and Mounted Brigades.

Infantry Division Signal Companies.—Are divided into 4 sections.

No. 1 Section consists of 3 cable detachments each with 10 miles of cable and 3 vibrator offices, 4 mounted men, 8 cyclists, and 9 motor cyclists.

It is used for communication within the Division as required.

Nos. 2, 3, and 4 Sections. 2 telephone detachments (pack), each with 4 miles of cable and 5 portable telephones, and 8 cyclists.

They are used for communication within the Infantry Brigades or as required.

Cavalry Division Signal Squadron.—Is divided into 4 troops.

“A” Troop.—2 wireless long distance stations (80 miles), and is used for communication between Cavalry Division Headquarters and General Headquarters.

“B” Troop.—2 cable detachments with 30 miles of cable and 6 vibrator offices, for general communication within the Division and to keep Division Headquarters in touch with the wireless stations serving it.

“C” Troop.—1 (long distance) wireless station and 3 (pack) wireless stations (20—30 miles), for communication between Division Headquarters and brigades or contact squadrons.

“D” Troop.—11 mounted men, 28 cyclists, 6 motor cyclists, 2 motor cars, for visual signalling and despatch riding in conjunction with other means of signalling.

Signal Troop with Cavalry Brigade.—11 mounted men, 6 cyclists, 3 motor cyclists, for visual signalling and despatch riding.

7 $\frac{2}{3}$ miles of cable (pack), 8 portable telephones, for use with outposts and for tapping and making use of existing permanent lines.

Signal Troop with Mounted Brigade.—As for Signal Troop with Cavalry Brigade, with the addition of 2 wireless (pack) stations, for communication with General and Cavalry Division Headquarters.

2.—The *personnel* mentioned in units other than signal units and the telephone equipment and number of bicycles provided are as follows :—

Unit.	Signal Officer.	Signal Sergeant.	Rank and File.	Bicycles (e).	Remarks.
Hdqrs. Cavalry Division Artillery	—	—	4 (a)	3	(a) Trained signallers.
„ Divisional Artillery	—	—	4 (a)	3	
„ Cavalry Div. Engineers...	—	—	—	1	
„ Divisional Engineers	—	—	—	1	(b) Trained in signalling and telephonist's duties.
Cavalry Regiment	—	I	18 (a)	15	
Yeomanry Squadron	—	—	2 (d)	2	
Horse Artillery Brigade :—					
Headquarters	—	—	7 (b) (c)	3	
Battery	—	—	6 (b)	3	(c) Does not include driver for cable wagon.
Ammunition Column	—	—	4 (b)	3	
Horse Artillery Battery and Mounted Brigade Ammunition Column	—	—	9 (b)	4	(d) 2 bicyclist despatch riders.
Field Artillery Brigade :—					
Headquarters	—	—	9 (b) (c)	1	
Battery	—	—	6 (b)	1	
Ammunition Column	—	—	5 (b)	1	
Field Artillery (How.) Brigade :—					(e) Provided for despatch riding and use of signallers as required.
Headquarters	—	—	7 (b) (c)	1	
Battery	—	—	6 (b)	1	
Ammunition Column	—	—	3 (b)	1	
Heavy Artillery Battery and Ammunition Column	—	—	8 (b) (c)	1	
Divisional Ammunition Column	—	—	6 (a)	1	
Field Troops	—	—	2 (a)	1	
Field Companies	—	—	3 (a)	1	
Balloon Companies	—	—	2 (a)	1	
Bridging Trains	—	—	—	1	
Infantry Battalions	I	I	24 (a)	9	
Mounted Infantry Battalion	—	I	18 (a)	15	
Mounted Infantry Company	—	—	6 (a)	5	
Cavalry Division Train	—	—	—	5	
Divisional Train	—	—	—	2	
Mounted Brigade Train	—	—	—	1	
Cavalry Field Ambulance	—	—	—	2	
Field Ambulances	—	—	—	1	

TELEPHONE EQUIPMENT.

	Telephones Portable D Mk. II.	Cable Miles.	Remarks.
Horse Artillery Brigade			
Field „ „ } Headquarters	6	6	Carried on wagon.
Field Artillery Howr. Bde. } Battery	4	1 $\frac{5}{8}$	Carried by mounted men.
Horse Artillery Battery with Mounted Brigade	4	1 $\frac{5}{8}$	Carried by mounted men.
Heavy Artillery Battery { $\frac{1}{2}$ Battery ..	4	1 $\frac{5}{8}$	Carried by mounted men.
Battery ..	6	6	Carried on wagon.

MEANS EMPLOYED BY SIGNAL COMPANIES TO PROVIDE AND MAINTAIN COMMUNICATION.

1.—*Field Air Line*.—Bare wire erected on light poles. A detachment of 12 N.C.O.'s and men can erect about 5 miles a day, rate $\frac{1}{2}$ to 2 miles an hour.

2.—*Field Cable*.—Insulated wire laid on the ground (D₅, weight 80 lbs. per mile) ; detachment consists of 8 N.C.O.'s and men ; rate 1—6 miles per hour (average 3).

(For Artillery cable wagon, cable (D₃) of 40 lbs. per mile is used, and for Infantry Brigade Sections and Artillery Batteries, cable (D₁) of 12 lbs. to the mile is used).

3.—*Wireless Stations*.—A wagon station can maintain communication with a similar station up to about 80 miles and with pack station up to about 30 miles.

Two pack stations can work with each other 20 to 30 miles apart.

4.—*Visual Signalling*.—Helio, distance limited by range of vision. Flag, 3 to 7 miles.

Lamp, limelight, 10—15 miles.

Lamp, Begbie, 5—8 miles.

Deitz disc.

5.—*Despatch Riding*.—Horses, bicycles, motor cycles, and motor cars. Pace depends on means, nature of country and traffic, etc.

ADMINISTRATION OF ARMY SIGNAL SERVICE.

The Army Signal Service is administered by the Director of Army Signals with an A.D.A.S. as his Staff Officer.

He has representatives at the following Headquarters :—

At Headquarters of I.G.C., by a D.D.A.S.

At Headquarters of an Army, by an O. i/c Signals.

At Headquarters of a Cavalry Division, by an O. i/c Signals.

At Headquarters of an Infantry Division, by an O. i/c Signals.

At Headquarters of a Mounted Brigade, by an O. i/c Signals.

ORGANIZATION FOR WORK.

At General and Army Headquarters a Signal Office and Telegraph Office.

Signal Office—Divisible for movement, keeps register of method of transmission of all messages, decides method of transmission if not specially detailed by Staff.

Telegraph Office—Has charge of all telegraph and signalling lines. Advises Signal Office of breakdowns and delays.

At Divisional Headquarters similar methods on smaller scale.

Personnel for Signal and Telegraph Offices are found from Headquarters Sections of Air Line and Cable Companies.

D.A.S. allots sections for work under O. i/c Signals ; issues instructions for lines to be erected, maintained or dismantled.

O. i/c Signals of Armies, Divisions, etc., issue orders for work under instructions from their Staff.

Necessity for Signal Officers to know as much as possible of situation and plans.

Communications from Advance Base to General Headquarters. Two lines—Wheatstone—Duplex—Simplex.

Communications from General Headquarters to Army Headquarters. Simplex—Vibrator—Diplex.

Communications from Army Headquarters to Division Headquarters. Advance—Retirement.

Communication within an Infantry Division. Advance—Retirement. Main Body to Advance Guard. Billets and Camps.

Communications with cavalry. Necessity of cypher with wireless.

